

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the manufacturing method and device of the optical fiber which heats and draws a line in an optical fiber preform, and manufactures an optical fiber. Specifically, this invention relates to the optical fiber manufacturing method and optical fiber manufacturing installation which correct inclination to the perpendicular direction of an optical fiber preform, and raise the quality of the optical fiber manufactured.

[0002]

[Description of the Prior Art] The optical fiber which has a clad with a diameter of 125 micrometers formed in heating and the periphery of a core [carry out the rarefaction, manufacture an optical fiber preform, and heat and draw a line in the optical fiber preform further, for example,] 10 micrometers in diameter and its core in the optical fiber soot preform which deposited and compounded glass particles is manufactured. Since an optical fiber is such very thin, the outer diameter control must be performed correctly. Therefore, it is desirable for the center of an optical fiber preform to be perpendicularly in agreement correctly.

[0003] On the other hand, there is a request of making the manufacture price of an optical fiber low with expansion of utilization of an optical fiber, and enlargement of the optical fiber preform is attained. For example, the latest optical fiber preform also has a thing exceeding 2 m in length, and the weight of 40 kg.

[0004]

[Problem(s) to be Solved by the Invention] Enlargement of an optical fiber preform makes the following problem cause. As the optical fiber preform whose weight it is long and is heavy was illustrated to drawing 9 (A) only by making the upside supporter grasp, the optical fiber preform itself bends and a lower end part vibrates. Such vibration takes place by the maldistribution of the center of gravity by bend of an optical fiber preform, vertical motion of an optical fiber preform, disorder of the flow of the gas in a drawing furnace, etc., and vibration may continue and it may not stop.

[0005] If an optical fiber preform vibrates, the quality of the optical fiber on which a line was drawn will be reduced so that it may state below. The temperature change of the meniscus section of an optical fiber preform by which heat melting is carried out with the heater in a drawing furnace becomes large, and change of the diameter of an optical fiber becomes large as a result. When vibration of an optical fiber preform becomes large, the outside-diameter-measurement device which performs outside diameter measurement of the optical fiber on which a line was drawn in the lower part of a drawing furnace may be contacted.

[0006] If the position of an optical fiber preform is unevenly distributed to the center of a drawing furnace and the tip part (meniscus section) of an optical fiber preform fuses, the temperature distribution of a meniscus section will become unsymmetrical to the center of an optical fiber preform, and the section of an optical fiber will not become a perfect circle.

[0007] As a method of solving such a problem, as illustrated to drawing 10, for example, Grasp the supporter 13 of the optical fiber preform 1 by the gripping instrument 37, and the gripping instrument 37 is horizontally moved with the horizontal drive 38, The method of adjusting horizontally the position of the optical fiber preform 1 and the position of the optical fiber 3 is easily considered from the contents indicated to JP,54-28156,A, for example. Line C-C shows the perpendicular direction which shows the drawing center of the optical fiber 3. With the heater 53 of the drawing furnace 5, heat melting of the

optical fiber preform 1 is carried out, and it is pulled out as the optical fiber 3. However, since the inertia of an optical fiber preform is large when an optical fiber preform is enlarged, the response of horizontal migration cannot follow vibration late. When an optical fiber preform vibrates on the frequency of 1 Hz or more especially, in order to make such vibration follow, a considerable large-sized adjusting device is needed, but it is not practical as an optical fiber manufacturing installation from viewpoints of a price, a size, etc.

[0008]As illustrated in drawing 9 (B), the supporter of the optical fiber preform has bent and the lower end part of the optical fiber preform may have shifted from perpendicular direction C-C. In such a case, in the adjustment method by the horizontal migration mentioned above, it cannot be made in agreement in the perpendicular direction covering the overall length of an optical fiber preform, and a problem cannot be solved.

[0009]Since the tip part 17 of the optical fiber preform 1 is located near the heater 53 of the drawing furnace 5, it must drop the whole optical fiber preform caudad along with manufacture of an optical fiber. Since the mass of the optical fiber preform decreases as an optical fiber is furthermore manufactured, inertia changes, and oscillation characteristics (the size of vibration, the frequency of vibration, etc.) also change. Therefore, processing in accordance with the situation of the optical fiber preform is needed.

[0010]This invention conquers the problem mentioned above, and does not depend for it on vibration of an optical fiber preform, etc., but it is in being stabilized and providing the optical fiber manufacturing method which can manufacture a high optical fiber and optical fiber manufacturing installation of quality.

[0011]

[Means for Solving the Problem]In an optical fiber manufacturing method which according to this invention heats and draws a line in an optical fiber preform, and manufactures an optical fiber, (a) detecting inclination to a perpendicular direction of an optical fiber preform which is grasped by holding means and is hanging perpendicularly -- (b) -- an optical fiber manufacturing method which adjusts inclination of said holding means and corrects inclination of said optical fiber preform is provided.

[0012]In this invention, since vibration of an optical fiber preform, a bend, etc. are detected as inclination to the perpendicular direction and the inclination is corrected, a posture of an optical fiber preform can be adjusted appropriately. As a result, a high optical fiber of quality can be manufactured from an optical fiber preform by which attitude control was carried out.

[0013]On a drawing furnace and in [according to this invention] heating and an optical fiber manufacturing installation which draws a line and manufactures an optical fiber for an optical fiber preform, A holding means which grasps a head of said optical fiber preform, and a fixing means which supports said holding means, A justification means for it to be provided between said holding means and said fixing means, and to adjust distance of said holding means or inclination to said fixing means, A position gap detection means to detect a gap of a perpendicular direction of said optical fiber preform which a head is supported by said holding means and is hanging, Based on a position gap detection value of said position gap detection means, an optical fiber manufacturing installation possessing a control means which drives said justification means and corrects a position gap of said optical fiber preform is provided.

[0014]In this invention, since it is a position gap detection means, vibration of an optical fiber preform, a bend, etc. are detected as inclination to the perpendicular direction and the inclination is corrected by a

justification means in a head of an optical fiber preform, a posture of an optical fiber preform can be adjusted appropriately. As a justification means, said justification means has a preferred piezoelectric element etc. which are displaced according to impression of voltage from viewpoints of speed of small size and a response, etc. Therefore, sufficient response can be realized even when an optical fiber preform vibrates on high frequency.

[0015]Two or more mass detection means or two or more weight detecting means which said position gap detection means was formed in said holding means, and have been arranged in distribution of mass of said optical fiber preform, or weight so that detection is possible, It may have a calculating means which computes the position gap direction and the amount of position gaps from a difference of a detection value of a detection means of these plurality. Said detection means are a strain gage, a load cell, etc., for example.

[0016]As for said position gap detection means, it is preferred that a position sensing device which detects a position gap to a perpendicular direction medial axis of an optical fiber preform before being introduced into said drawing furnace, for example, a noncontact type laser position sensor, is included.

[0017]As for said position gap detection means, it is still more preferred that a position sensing device which detects a position gap to a perpendicular direction medial axis of an optical fiber on which a line was drawn with said drawing furnace is included.

[0018]

[Embodiment of the Invention]Two or more suitable embodiments of the optical fiber manufacturing installation of this invention are described with reference to an accompanying drawing.

[0019]1st embodiment drawing 1 is a sectional view of a 1st embodiment of the optical fiber manufacturing installation of this invention. Drawing 2 (A) is a sectional view in line A-A of drawing 1, drawing 2 (B) is a sectional view in line B-B of drawing 1, and drawing 2 (C) is a figure showing the fixing position of the strain gage in the optical fiber manufacturing installation diagrammatic to drawing 1, and an actuator. The optical fiber manufacturing installation which draws a line in the optical fiber preform 1 diagrammatic to drawing 1, and manufactures the optical fiber 3 is provided with the following.

Drawing furnace 5.

The gripping instrument 7 which is located in the upper part of the drawing furnace 5, grasps the base material head 15 of the optical fiber preform 1, and is fixing the optical fiber preform 1.

The base 8 of the gripping instrument which is located in the lower part of the gripping instrument 7, and supports the gripping instrument 7.

The strain gage 10, the piezoelectric element (piezo actuator) 12, and the control device 20.

Of course, although the diameter measurement machine of the optical fiber which is not illustrated, the resin coating device, the take-up motion, etc. are formed as an optical fiber manufacturing installation, it is a relation of an illustration and the illustration of a portion which is not directly related to this invention is deleted from drawing 1.

[0020]The supporter (thin diameter section) 13 of the optical fiber preform 1 passes along the hole 71 of the gripping instrument 7, and the hole 81 of the base 8 of a gripping instrument, and the base material head 15 of the head of the optical fiber preform 1 is grasped by the gripping instrument 7. The gripping instrument 7 is supported on the base 8 of the gripping instrument via the piezo actuator 12. As a result, the optical fiber preform 1 by which the base material head 15 was grasped by the gripping instrument 7

is hanging inside the drawing furnace 5.

[0021]As the strain gage 10 was illustrated to drawing 2 (A) in practice, it is the four strain gages 10A-10D, and these four strain gages maintain the interval of 45 degrees, respectively, and they are embedded at the gripping instrument 7 so that the base material head 15 of the optical fiber preform 1 may be contacted. By embedding the four strain gages 10A-10D at the gripping instrument 7 so that the base material head 15 may be contacted, the weight of the optical fiber preform 1 currently grasped by the gripping instrument 7 is measurable. It is connected to the control device 20 and the four strain gages 10A-10D can measure the weight of the optical fiber preform 1 in the control device 20. If the four strain gages 10A-10D are used, the distribution within the level surface of the optical fiber preform 1 is measurable. According to the distribution within this field, the bending direction of the optical fiber preform 1 is detectable in the control device 20. That is, if the mutual error of the detection value of the four strain gages 10A-10D is computed with the control device 20, X of the optical fiber preform 1 and bending of the direction (the direction of two dimensions) of Y are detectable. Thus, it functions as a position gap detection means by which the gripping instrument 7, the strain gages 10A-10D, and the control device 20 detect a position gap of the optical fiber preform 1, bending, etc.

[0022]In practice, as illustrated to drawing 2 (B), it is the four piezo actuators 12A-12D, and these four piezo actuators also maintain the interval of 45 degrees, respectively, and the piezo actuator 12 is also formed between the bases 8 of the gripping instrument 7 and a gripping instrument. In this embodiment, as illustrated to drawing 2 (C), the strain gages 10A-10D and the piezo actuators 12A-12D are allocated in the same angular position. However, the installation direction of the strain gages 10A-10D and the piezo actuators 12A-12D does not need to be set as the same angular position. The piezo actuators 12A-12D are displaced according to impression of voltage. Displacement of the piezo actuators 12A-12D changes distance with the base 8 of the gripping instrument 7 and a gripping instrument, and inclination. Since the base 8 of the gripping instrument is being fixed, inclination of the gripping instrument 7 changes. If inclination of the gripping instrument 7 changes, inclination (posture) of the optical fiber preform 1 by which the base material head 15 is grasped by the gripping instrument 7 will also change. Thus, the piezo actuators 12A-12D function as a justification means in this invention with the control device 20. Therefore, the control device 20 drives the piezo actuators 12A-12D via the drive circuit which is not illustrated so that it may mention later. Since the piezo actuators 12A-12D answer voltage impressing promptly and cause change of displacement, they can cause displacement (change of inclination) for the gripping instrument 7 promptly to the base 8 of a gripping instrument, and can change the posture of the optical fiber preform 1.

[0023]The base material body part 11 of the optical fiber preform 1 which is hanging is located in the drawing furnace container 51 of the drawing furnace 5. The heater 53 is formed in the inside of the drawing furnace 5, and the lower tip part of the base material body part 11 of the optical fiber preform 1 introduced into the inside of the drawing furnace container 51 is heated and carried out. Since the lower end part of the optical fiber preform 1 is pulled outside, melting of the lower end part of the optical fiber preform 1 heated with the heater 53 is carried out, it turns into the meniscus section 17, serves as the optical fiber 3 from the meniscus section 17, and is pulled out by the exterior of the drawing furnace 5. The optical fiber 3 consists of a clad whose diameter formed in the periphery of a core 10 micrometers in diameter and a core, for example is 125 micrometers. Thus, an outer diameter is measured with an outer diameter measuring instrument (not shown), further, resin is covered with a resin coating device (a figure is not carried out) by the periphery of the optical fiber 3, and the formed optical fiber 3 is rolled

round with it.

[0024]It learns, if the optical fiber preform 1 is not dropped with manufacture of the optical fiber 3, and it is **. Therefore, the base 8 of the gripping instrument 7 which is supporting the optical fiber preform 1, and the gripping instrument which is supporting the gripping instrument 7 via the piezo actuator 12 descends along with manufacture of the optical fiber 3 with the mechanism which is not illustrated. As a result, the meniscus section 17 is always formed in the portion of the heater 53, and the optical fiber 3 is manufactured.

[0025]The control device 20 as a control means of this invention controls drawing of the optical fiber 3 mentioned above, and also performs the attitude control of the optical fiber preform 1 described below. Hereafter, with reference to drawing 3, the perpendicular direction position control (attitude control) of the optical fiber preform 1 in the control device 20 is described.

[0026]Steps 1 and 2: The control device 20 reads the detecting signal of the four strain gages 10A-10D the whole predetermined sampling period (S1), and computes the difference of the mutual value of these detecting signals (S2).

[0027]If the optical fiber preform 1 assumes that weight has balanced focusing on center line C-C, it is possible that the mutual difference of these detecting signals shows inclination of the optical fiber preform 1. For example, if it becomes deviation $\text{deltaw1} = (\text{reading of reading-strain gage 10C of strain gage 10A}) \geq 0$, Since the optical fiber preform 1 has started the strain gage 10A heavily from the strain gage 10C, it can be considered that the optical fiber preform 1 leans 225 degrees from the center C on a 45 - 225 degree line in drawing 2 (C) at the side (strain gage 10C side). The deviation deltaw1 shows the grade of the inclination. That is, if the following operation is performed in the control device 20, each deviation shows an inclination direction and its extent.

[0028]

[Table 1]

Deviation $\text{deltaw1} = (\text{reading of the reading-strain gage 10C of the strain gage 10A})$

Deviation $\text{deltaw2} = (\text{reading of the reading-strain gage 10D of the strain gage 10B})$

Deviation $\text{deltaw3} = (\text{reading of the reading-strain gage 10B of the strain gage 10A})$

Deviation $\text{deltaw4} = (\text{reading of the reading-strain gage 10C of the strain gage 10B})$

Deviation $\text{deltaw5} = (\text{reading of the reading-strain gage 10D of the strain gage 10C})$

Deviation $\text{deltaw6} = (\text{reading of the reading-strain gage 10A of the strain gage 10D})$

[0029]If it becomes $\text{deltaw1} \geq 0$, only the angle at which the optical fiber preform 1 is equivalent to a side 225 degrees in a line deltaw1 45 to 225 degrees leans from line C-C. If it becomes $\text{deltaw2} \geq 0$, only the angle at which the optical fiber preform 1 is equivalent to a side 315 degrees in a line deltaw2 315 to 135 degrees leans from line C-C. If it becomes $\text{deltaw3} \geq 0$, only the angle at which the optical fiber preform 1 is equivalent to the strain gage 10A side on both sides of a line deltaw3 0 times leans from line C-C. If it becomes $\text{deltaw4} \geq 0$, only the angle at which the optical fiber preform 1 is equivalent to the strain gage 10B side on both sides of a line deltaw4 270 degrees leans from line C-C. If it becomes $\text{deltaw5} \geq 0$, only the angle at which the optical fiber preform 1 is equivalent to the strain gage 10C side on both sides of a line deltaw5 180 degrees leans from line C-C. If it becomes $\text{deltaw6} \geq 0$, only the angle at which the optical fiber preform 1 is equivalent to the strain gage 10D side on both sides of a line deltaw6 90 degrees leans from line C-C.

[0030]Of course, inclination of the optical fiber preform 1 is not limited in the six directions mentioned above. For example, it is $\text{deltaw1} \geq 0$, and if it becomes $\text{deltaw2} \geq 0$, it means that the optical fiber

preform 1 leans in the intermediate direction of 270 degrees of 225 degrees and 315 degrees, i.e., the direction. $\Delta w_3 \geq 0$ [in this case,] -- and if it becomes $\Delta w_5 \geq 0$, the optical fiber preform 1 will actually lean to the direction from line C-C 270 degrees. The grade of the inclination is an angle equivalent to the value shown by Δw_3 and Δw_5 . The control device 20 computes the inclination direction and its degree of angle of inclination of the optical fiber preform 1 in this way by judging synthetically the value of the deviations Δw_1 - Δw_6 . The control device 20 faces the degree of angle of inclination, and an inclination direction calculation, According to the length of the optical fiber preform 1, weight, etc., reading of the strain gages 10A-10D measures a priori the deviation mentioned above as criterion data about various kinds of degrees of angle of inclination and inclination directions, and an inclination direction and the degree of angle of inclination are determined with reference to the criterion data.

[0031] In order to face computing the above-mentioned difference using the detecting signal of the strain gages 10A-10D, to remove removal of a noise, and a vibration component and to improve the reliability of signal processing, after filtering-processing or equalizing the detection value which carried out the prescribed frequency sampling, it is desirable to use it for the operation of the above-mentioned difference.

[0032] **Step 3:** When the inclination direction and the degree of angle of inclination of the optical fiber preform 1 are detected, the control device 20 determines the angle and direction of [for adjusting inclination of the gripping instrument 7 which is grasping the base material head 15] so that the inclination may be offset. Furthermore, the control device 20 determines the drive quantity of the piezo actuators 12A-12D for adjusting the gripping instrument 7 to such the angular position further. The amount of angle adjustments of the gripping instrument 7 in the control device 20, For example, it measures how the angle of the gripping instrument 7 and direction should be adjusted according to the inclination direction and the degree of angle of inclination of the optical fiber preform 1 a priori, it is memorized in the memory with the gestalt of the table, and a table-look-up method and its interpolation system can determine. That is, the angle of the gripping instrument 7 and direction are determined about the conditions measured by the table-look-up method, and it interpolates from adjoining data about the portion which is not memorized on a table. Similarly the drive quantity of the piezo actuators 12A-12D in the control device 20, For example, the angle of the various gripping instruments 7 and the amount of displacement of the piezo actuators 12A-12D to direction combine with beforehand, and it measures, and memorizes in the memory with the gestalt of the table, and a table-look-up method and its interpolation system can determine.

[0033] **Step 4:** The control device 20 drives the above-mentioned piezo actuators 12A-12D via the drive circuit which is not illustrated. The piezo actuators 12A-12D are piezoelectric elements, and the displacement according to the impressed voltage changes. The control signal for the attitude control of the optical fiber preform 1 is outputted to the piezo actuators 12A-12D from the control device 20, If impressed by the piezo actuator to which driver voltage corresponds from the drive circuit (not shown) which generates the piezo actuator driver voltage according to the control signal, the displacement according to impressed electromotive force will arise. The distance between the bases 8 of the gripping instrument 7 and a gripping instrument changes with the sizes of this displacement. If there is change of inclination of the gripping instrument 7 to the base 8 of a gripping instrument, the posture of the perpendicular direction of the optical fiber preform 1 currently grasped by the gripping instrument 7 will change. Therefore, the chinning-exercises posture of the optical fiber preform 1 is appropriately

controllable by outputting a suitable attitude control signal from the control device 20. The piezo actuators 12A-12D change displacement promptly according to voltage impressing. Therefore, the piezo actuators 12A-12D can be used as a high-speed actuator.

[0034]Step 5: Only predetermined time is delayed and the control device 20 repeats operation of Step 1 again. It is because this time delay took into consideration the dead time resulting from the response delay of displacement of the gripping instrument 7 accompanying the drive of the piezo actuators 12A-12D, and the attitude control of the optical fiber preform 1, and this delay is not necessarily indispensable.

[0035]Drawing 4 (A) is a graph which shows vibration of the optical fiber preform 1. When the optical fiber preform 1 is enlarged, it may vibrate with the cycle of about 0.3 second with the amplitude of about a maximum of 1 mm. Also about vibration of such an optical fiber preform 1, according to this embodiment, it follows enough and the posture of the optical fiber preform 1 can be adjusted appropriately. Drawing 4 (B) is a graph which shows the amount of displacement of the piezo actuators 12A-12D driven for the attitude control of the optical fiber preform 1. In this illustration, displacement of about a maximum of 20 micrometers is caused, and inclination of the gripping instrument 7 and by extension, inclination of the optical fiber preform 1 are adjusted.

[0036]Although the embodiment, as for, the 1st of a 1st embodiment carried out modification mode **** described the case where the optical fiber preform 1 was carrying out shape where balance was maintained ideally, As the optical fiber preform 1 illustrated to drawing 9 (B), the supporter 13 has bent from the beginning, for example, and eccentricity may be carried out from perpendicular direction C-C. The control device 20 performs angle control of the gripping instrument 7 described with reference to drawing 3, and enables it to manufacture the suitable optical fiber 3 from the optical fiber preform 1 in an initial state so that attitude control may be appropriately possible also about such an optical fiber preform 1. As a result, even if there is a bend of the supporter [as] 13 diagrammatic to drawing 9 (B), the high optical fiber 3 of quality can be manufactured.

[0037]If manufacture of the 2nd modification mode optical fiber 3 of a 1st embodiment progresses, the weight of the optical fiber preform 1 will become light, and length will also become short. If it becomes so, generally vibration of the optical fiber preform 1 will tend to become small. Also in this case, in order to perform the suitable attitude control of ***** 1 and to continue manufacturing the quality optical fiber 3. The control device 20 measures the weight of the optical fiber preform 1 from the measurement value of the strain gages 10A-10D, and computes the angular position of the gripping instrument 7 according to the weight at that time, and the amount of displacement of the piezo actuators 12A-12D. the angular position of the gripping instrument [beforehand] 7 according to weight also in this case -- and, The amount of displacement of the piezo actuators 12A-12D is measured, and the angular position of the gripping instrument 7 according to the weight of the ** and the amount of displacement of the piezo actuators 12A-12D are computed with a table-look-up method and an interpolation system. As a result, the high optical fiber 3 of quality can be manufactured from the initial state of the optical fiber preform 1 to a final state.

[0038]It may change into measurement of the weight of the optical fiber preform 1 using the strain gages 10A-10D, and the weight of the optical fiber preform 1 may be presumed from the production time of the optical fiber 3.

[0039]As stated above, according to a 1st embodiment, even if vibration of the optical fiber preform 1, a bend of the supporter 13, the weight change of the optical fiber preform 1, etc. occur, the high optical

fiber 3 of quality can be manufactured continuously.

[0040]2nd embodiment drawing 5 is a sectional view of a 2nd embodiment of the optical fiber manufacturing installation of this invention. Drawing 6 (A) is a sectional view in line A-A of drawing 5, drawing 6 (B) is a sectional view in line B-B of drawing 5, and drawing 6 (C) is a figure showing the fixing position of the position detection sensor in the optical fiber manufacturing installation diagrammatic to drawing 5, and an actuator. The optical fiber manufacturing installation diagrammatic to drawing 5 is provided with the following.

Drawing furnace 5.

The gripping instrument 7 which is located in the upper part of the drawing furnace 5, grasps the base material head 15 of the optical fiber preform 1, and is fixing the optical fiber preform 1.

The base 8 of the gripping instrument located in the lower part of the gripping instrument 7.

The optical fiber preform position sensing device 14, and the piezo actuator 12, the control device 20.

The optical fiber manufacturing installation diagrammatic to drawing 5 deleted the strain gages 10A-10D diagrammatic to drawing 1 and drawing 2 (A), and has formed the optical fiber preform position sensing device 14 located in the upper part of the drawing furnace 5. The position detection signal of the position sensing device 14 is inputted into the control device 20. Other composition is the same as that of the optical fiber manufacturing installation diagrammatic to drawing 1.

[0041]The optical fiber preform position sensing device 14 is a noncontact type laser position sensor, and measures the distance from time until it irradiates the surface of the optical fiber preform 1 with the light from laser and receives the catoptric light to the optical fiber preform 1, for example. Since the outer diameter of the optical fiber preform 1 is known a priori, if the distance to the surface of the optical fiber preform 1 can be measured, the position gap from the extending direction of the optical fiber preform 1 is computable in the control device 20.

[0042]With reference to drawing 7, the attitude control of the optical fiber preform 1 in the control device 20 in a 2nd embodiment is described.

[0043]Steps 1A and 1B: The control device 20 reads the detecting signal of the optical fiber preform position sensing device 14 (S1A), and computes the position gap from [of the optical fiber preform 1] perpendicular from the detecting signal (S1B). In order to face computing the above-mentioned position gap using the detecting signal of the optical fiber preform position sensing device 14, and for removal of a noise and a vibration component to remove and to improve the reliability of signal processing, it is desirable to use the detection value which carried out the prescribed frequency sampling, filtering-processing or equalizing.

[0044]Steps 3, 4, and 5: It is the same as the method described with reference to drawing 3.

[0045]As stated above, according to a 2nd embodiment, even if vibration of the optical fiber preform 1, a bend of the supporter 13, the weight change of the optical fiber preform 1, etc. occur, the high optical fiber 3 of quality can be continuously manufactured like a 1st embodiment.

[0046]Although the embodiment, as for, the 1st of a 2nd embodiment carried out modification mode **** described the case where the optical fiber preform 1 was carrying out shape where balance was maintained ideally, As the optical fiber preform 1 illustrated to drawing 9 (B), the supporter 13 has bent from the beginning, for example, and eccentricity may be carried out from perpendicular direction C-C. So that attitude control may be appropriately possible also about such an optical fiber preform 1, The control device 20 performs angle control of the gripping instrument 7 described with reference to

drawing 7, and enables it to manufacture the suitable optical fiber 3 from the optical fiber preform 1 in an initial state like the 1st modification mode of a 1st embodiment also in the 1st modification mode of a 2nd embodiment. As a result, even if there is a bend of the supporter [as] 13 diagrammatic to drawing 9 (B), the high optical fiber 3 of quality can be manufactured.

[0047]If manufacture of the 2nd modification mode optical fiber 3 of a 2nd embodiment progresses, the weight of the optical fiber preform 1 will become light, and length will also become short. If it becomes so, generally vibration of the optical fiber preform 1 will tend to become small. Also in this case, in order to perform the suitable attitude control of ***** 1 and to continue manufacturing the quality optical fiber 3. The control device 20 computes the angular position of the gripping instrument 7 according to the weight of the optical fiber preform 1 at that time, and the amount of displacement of the piezo actuators 12A-12D by presuming the weight of the optical fiber preform 1 from the production time of the optical fiber 3. the angular position of the gripping instrument [beforehand] 7 according to weight also in this case -- and, The amount of displacement of the piezo actuators 12A-12D is measured, and the angular position of the gripping instrument 7 according to the weight of the ** and the amount of displacement of the piezo actuators 12A-12D are computed with a table-look-up method and an interpolation system. As a result, the high optical fiber 3 of quality can be manufactured from the initial state of the optical fiber preform 1 to a final state.

[0048]In order to measure still more correctly the position gap from [of the 3rd modification mode optical fiber preform 1 of a 2nd embodiment] perpendicular, As the dashed line showed to drawing 5, the base material head 14A is formed in the position which intersects perpendicularly with the optical fiber preform position sensing device 14, the optical fiber preform position sensing device 14 detects a position gap of a direction 0 to 180 degrees, and the optical fiber preform position sensing device 14A detects a position gap of a direction 90 to 270 degrees. Then, position gap detection of the optical fiber preform 1 in the control device 20 becomes exact, and the attitude control of the much more exact optical fiber preform 1 of it becomes possible.

[0049]As stated above, according to a 2nd embodiment, even if vibration of the optical fiber preform 1, a bend of the supporter 13, the weight change of the optical fiber preform 1, etc. occur, the high optical fiber 3 of quality can be continuously manufactured like a 1st embodiment.

[0050]3rd embodiment drawing 8 is a sectional view of a 3rd embodiment of the optical fiber manufacturing installation of this invention. Drawing 6 (A) - drawing 6 (C) are applicable also to a 3rd embodiment. The optical fiber manufacturing installation diagrammatic to drawing 8 is provided with the following.

Drawing furnace 5.

The gripping instrument 7 which is located in the upper part of the drawing furnace 5, grasps the base material head 15 of the optical fiber preform 1, and is fixing the optical fiber preform 1.

The base 8 of the gripping instrument located in the lower part of the gripping instrument 7.

The optical fiber position sensing device 16, and the piezo actuator 12, the control device 20.

The optical fiber manufacturing installation diagrammatic to drawing 8 is replaced with the optical fiber preform position sensing device 14 diagrammatic to drawing 5, and forms the optical fiber position sensing device 16. The position sensing device 16 is connected to the control device 20. Other composition is the same as that of the optical fiber manufacturing installation diagrammatic to drawing 5.

[0051]The optical fiber preform position sensing device 14 is a noncontact type laser position sensor, and measures the distance from time until it irradiates the surface of the optical fiber 3 with the light from laser and receives the catoptric light to the optical fiber preform 1, for example. Since the diameter of the optical fiber 3 is as thin as about 125 micrometers, the distance to the surface of the optical fiber 3 can consider the center position of the optical fiber 3, and the position gap from [of the optical fiber 3] perpendicular can compute in the control device 20 from reading of the optical fiber preform position sensing device 14.

[0052]The attitude control of the optical fiber preform 1 in the control device 20 is the same as that of a 2nd embodiment described with reference to drawing 7. Therefore, according to a 3rd embodiment, like a 2nd embodiment, even if vibration of the optical fiber preform 1, a bend of the supporter 13, the weight change of the optical fiber preform 1, etc. occur, the high optical fiber 3 of quality can be manufactured continuously. About the portion from which the position gap with perpendicular direction C-C poses a problem most in a 3rd embodiment as compared with a 2nd embodiment, since the optical fiber position sensing device 16 has detected the position gap, the attitude control of the more exact optical fiber preform 1 becomes possible.

[0053]Although the embodiment, as for, the 1st of a 3rd embodiment carried out modification mode **** described the case where the optical fiber preform 1 was carrying out shape where balance was maintained ideally, As the optical fiber preform 1 illustrated to drawing 9 (B), the supporter 13 has bent from the beginning, for example, and eccentricity may be carried out from the perpendicular direction. So that attitude control may be appropriately possible also about such an optical fiber preform 1, The control device 20 performs angle control of the gripping instrument 7 described with reference to drawing 7, and enables it to manufacture the suitable optical fiber 3 from the optical fiber preform 1 in an initial state like the 1st modification mode of a 2nd embodiment also in the 1st modification mode of a 3rd embodiment. As a result, even if there is a bend of the supporter [as] 13 diagrammatic to drawing 9 (B), the high optical fiber 3 of quality can be manufactured.

[0054]If manufacture of the 2nd modification mode optical fiber 3 of a 2nd embodiment progresses, the weight of the optical fiber preform 1 will become light, and length will also become short. If it becomes so, generally vibration of the optical fiber preform 1 will tend to become small. Also in this case, in order to perform the suitable attitude control of ***** 1 and to continue manufacturing the quality optical fiber 3. The control device 20 computes the angular position of the gripping instrument 7 according to the weight of the optical fiber preform 1 at that time, and the amount of displacement of the piezo actuators 12A-12D by presuming the weight of the optical fiber preform 1 from the production time of the optical fiber 3 like the 2nd modification mode of a 2nd embodiment. the angular position of the gripping instrument [beforehand] 7 according to weight also in this case -- and, The amount of displacement of the piezo actuators 12A-12D is measured, and the angular position of the gripping instrument 7 according to the weight of the ** and the amount of displacement of the piezo actuators 12A-12D are computed with a table-look-up method and an interpolation system. As a result, the high optical fiber 3 of quality can be manufactured from the initial state of the optical fiber preform 1 to a final state.

[0055]In order to measure still more correctly the position gap from [of the 3rd modification mode optical fiber preform 1 of a 3rd embodiment] perpendicular, As the dashed line showed to drawing 7, the base material head 16A is formed in the position which intersects perpendicularly with the optical

fiber preform position sensing device 14, the optical fiber preform position sensing device 16 detects a position gap of a direction 0 to 180 degrees, and the optical fiber preform position sensing device 16A detects a position gap of a direction 90 to 270 degrees. Then, detection of a position gap of the optical fiber preform 1 in the control device 20 becomes exact, and the attitude control of the much more exact optical fiber preform 1 of it becomes possible.

[0056]As stated above, according to a 3rd embodiment, even if vibration of the optical fiber preform 1, a bend of the supporter 13, the weight change of the optical fiber preform 1, etc. occur, the high optical fiber 3 of quality can be continuously manufactured like a 2nd embodiment.

[0057]Hereafter, the example of this invention is described.

The example over a 1st embodiment described with reference to 1st example drawing 1 - drawing 3 is described. The strain gages 10A-10D were attached to the gripping instrument 7. As the piezo actuators 12A-12D are detached 40 mm, respectively and were illustrated from the center position C to drawing 2 (B), the angle of 45 degrees was maintained and it attached between the bases 8 of four pieces, the gripping instrument 7, and a gripping instrument. The piezo actuators 12A-12D used that in which displacement of 20 micrometers occurs, respectively, when the voltage 100V was impressed. Inclination of about 1 mm generated the optical fiber preform 1 about 2000 mm (2 m) in length. Therefore, inclination of about 20 mm has been controlled by displacement of 20 micrometers of the piezo actuators 12A-12D for the optical fiber preform 1. As a result of performing speed of response at about 10 Hz, it ****(ed) to vibration of the several Hz optical fiber preform 1, and good control of flattery nature was completed. As compared with the control system especially diagrammatic to drawing 10, the response is markedly excellent. As a result, the good optical fiber 3 of quality has continued and manufactured. In this case, control accompanying the weight change of the optical fiber preform 1 was not performed.

[0058]It replaced with the other example strain gages 10A-10D, and as a result of experimenting also about the case where the optical fiber preform position sensing device 14 and the optical fiber position sensing device 16 are used, respectively, the same result as the 1st example was obtained. The strain gages 10A-10D, the optical fiber preform position sensing device 14, and the optical fiber position sensing device 16 are not always used alone, respectively, and two or more sorts may be simultaneously used for them.

[0059]

[Effect of the Invention]According to this invention, the position gap of an optical fiber preform decreased, the good optical fiber 3 of quality was stabilized, and it has manufactured to continuation. That is, the optical fiber manufactured by this invention had a section of a perfect circle mostly, there was also little change of the path of an optical fiber and the core and the clad were formed regularly.